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NATIONAL RECOVERY PLAN FOR THE MARBLED MURRELET

Recovery of Nationally Endangered Wildlife

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NATIONAL RECOVERY PLAN FOR THE MARBLED MURRELET

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Disclaimer

This is "Phase I" of the National Marbled Murrelet Recovery Plan. It has been prepared by members of the Marbled Murrelet Recovery Team, in consultation with others, to identify actions necessary for the conservation of this species' population in Canada. The plan does not necessarily represent official positions of the jurisdictional agencies or nongovernment organizations that participated in its development. Nor does it necessarily represent the views of all of the individuals involved in the plan's formulation. The proposals are far-reaching, and our ability to initiate the recovery recommendations is subject to appropriations, priorities, and budgetary constraints of the participating organizations.

Marbled Murrelets are a very poorly understood species, and modifications to the plan will be necessary as new findings affect management strategies and research priorities.

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Recovery plan summary

The major problem in developing a recovery plan for the Marbled Murrelet *Brachyramphus marmoratus* is the lack of knowledge about this atypical seabird. The Marbled Murrelet Recovery Team has decided that interim actions are required to reduce immediate threats to the species and to improve our understanding of its biology before a recovery plan can be prepared with confidence:

(1) Determine the current distribution and relative abundance of breeding populations:
   (a) in various coastal watersheds of the province, and
   (b) in the marine environment.

The Canadian Wildlife Service will coordinate this activity, but the cooperation and support of Parks Canada and the British Columbia Ministries of Forests and Environment, Lands and Parks are essential. More than $100 000 has already been invested in surveys, but the additional costs of basic population studies are expected to exceed $300 000.

(2) Identify the nesting habitat characteristics (forest type, tree size, stand size, elevation, slope, aspect, etc.). The British Columbia Ministry of Forests will coordinate this activity in cooperation with other agencies and industry. The Council of Forest Industries has raised some $160 000 for past field studies and is attempting to raise additional funds. About $220 000 is required.

(3) Identify the amount, distribution, and status of suitable nesting habitat. This is a shared responsibility of the British Columbia Ministry of Forests and the Canadian Wildlife Service. About $140 000 is required.

(4) Evaluate the direct and indirect mortality resulting from:
   (a) oil spills and petroleum pollution, and
   (b) by-catch in nets and other fishery interactions. Evaluate the impact of competition.

This activity requires an understanding of the population distribution (Item 1) and is the responsibility of the Canadian Wildlife Service. The British Columbia Ministry of Environment, Lands and Parks is leading the analysis of risk from oil spills through the Nestucca Trust Fund. Costs will exceed $700 000, but the results will benefit many coastal resources besides the Marbled Murrelet. The impact of fish nets needs further examination. The British Columbia Ministry of Environment, Lands and Parks plans to initiate interviews with gill-netters for an initial cost of $5000.

(5) Develop a simple population model as a framework for changing the species' status. Analysis of the population parameters will be initiated by the Recovery Team when sufficient information is available.

(6) Review and update the "Interim forest management recommendations to conserve Marbled Murrelet nesting habitat in coastal British Columbia, January 29, 1991" (Appendix 2). British Columbia's Ministry of Forests has initiated the development of new Biodiversity Guidelines.

Section 1. Introduction and background

1.1 Introduction

The Marbled Murrelet *Brachyramphus marmoratus* is a small member of the auk family of fish-eating seabirds. It occurs regularly throughout the coastal waters of British Columbia and can be seasonally abundant at some sites. It is unique among British Columbia's auks in that it appears to be noncolonial and nests in the crowns of coastal old-growth forest. British Columbia's other auks are colonial and nest on or beneath the ground. Although it shares outer coastal waters with other seabirds, the Marbled Murrelet is usually the only auk and most abundant fish-eating bird found deep in the coastal inlets (Campbell et al. 1990).

The designation of the Marbled Murrelet as a threatened species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was based on three threats from human activities: (a) the loss of nest sites as old-growth forests are harvested, (b) the loss of segments of the population to oil spills, and (c) the drain on the population as birds drown in fish nets.

This recovery plan examines the problems caused by the interactions of human activities and the Marbled Murrelet and recommends changes in policies, regulations, and conservation activities to mitigate immediate effects and research to understand those problems in the long term.

1.2 Evaluation of the Marbled Murrelet's current status

1.2.1 Factors influencing the vulnerability of Marbled Murrelets and contributing to their threatened status

1.2.1.1 Biological considerations

1.2.1.1.1 Status of the population: trends in numbers

We have no clear indication of trends in Marbled Murrelet populations. For more than 60 years, anecdotal reports have suggested occasional local declines (Brooks 1926; Pearse 1946; G.A. Poynter, pers. commun.), but these have not been followed by detailed studies. In a comprehensive review of incidental records and the few technical studies carried out in British Columbia, Campbell et al. (1990) found insufficient grounds to report a "change in status" since 1948. Only recently have systematic surveys begun to provide the quantitative data needed to estimate populations along sections of the coast (Robertson 1974; Carter 1984). Only small sections of the coast have been examined, and there are no replicates with which to construct trends.

Although effects of the three problems identified in the COSEWIC status report (Rodway 1990) have not been measured, human activity has increased the stress on populations. Direct mortality has been recorded from oil spills (e.g., Burger 1990) and gill nets (Carter and Sealy 1984), and there has been loss of nesting habitat as old-growth forests have been harvested (Rodway 1990). In the near future, stresses on the population may occur from proliferation of small boat harbours and the expansion of mariculture. No effect of the current boat traffic and marina development in the Strait of Georgia on Marbled Murrelet populations has been reported.

Although no population trends are clear in British Columbia, there is evidence elsewhere that the species' local populations are changing in number and distribution. This is particularly clear in northern California, where marine observations are concentrated offshore from the remnants of old-growth forest (Sowls et al. 1980; Nelson et al. 1987; Marshall 1988a, 1988b; Carter and Erickson 1988). A similar effect of forest fragmentation on Vancouver Island was implied by Pearse (1948).

The 1989 estimate of 45 000 individuals (Rodway 1990) is an extrapolation from densities determined by Robertson (1974) and Carter (1984) for parts of the west coast of Vancouver Island and applied to the range indicated by the Royal British Columbia Museum's site record cards

(Campbell et al. 1990). It has no valid statistical basis and should be used cautiously. It is now used as a reasonable working estimate by most people studying the species. Observations of birds at sea in May suggest that the breeding population is highly clumped and could be only half the current estimate (Kaiser et al. 1991). The increase in the frequency of murrelet observations that occurs in July in both terrestrial and marine areas (Eisenhawer and Reimchen 1990; Hamer and Cummins 1991; Rodway et al. 1991; Kaiser et al. 1991) demonstrates important seasonal variations, possibly due to the arrival of nonbreeding subadults, that can also affect population estimates.

In the current population estimates, significant geographic areas have not been examined. No murrelets have been reported from the valleys east of the Alaskan panhandle but within British Columbia. However, the waters of the panhandle are thought to hold the bulk of the Alaskan population, and the heads of Tarr, Chilkat, Chilkoot, and Taku inlets and the Unuk and Stikine rivers are close enough to the border that murrelets using those waters could nest in Canada. Similarly, until 1989, there were no records of Marbled Murrelets in the eastern section of the Gardner Canal (Kitlope River estuary), Portland Inlet, Grenville Inlet, and sections of Bute, Knight, and Rivers inlets. There are now a few records from the Kitlope River (J. Kelson, pers. commun.).

1.2.1.1.2 Status of the population: rate of decline

There is no estimate of the rate of change of any of the population parameters for Marbled Murrelets. The difficulty in marking and tracking individual birds means that no estimate is likely to be developed in the near future. Attempts to estimate trends may be confounded by short-term fluctuations as local populations respond to temporary changes in marine resources.

Understanding the age structure of the population is critical for conservation planning. Because we have no way of determining the average age or recruitment rate of young birds, the population could crash suddenly as it reaches senescence.

1.2.1.1.3 Current and past distribution

There are no records of large-scale changes in distribution and few records of local changes. High variance masks any trends in the Christmas Bird Count data (Rodway 1990). Bird-watchers have noted localized effects associated with the development of major industrial centres at Vancouver, Victoria, and Prince Rupert, where harbour activities (disturbance, persistent oil pollution, etc.) have decreased the abundance of many water birds. There is no quantification of those changes, although G.A. Poynter's (pers. commun.) series of Marbled Murrelet observations imply a decline in Burrard Inlet from hundreds to dozens.

1.2.1.1.4 Incidence of disease or pests

At least two juvenile Marbled Murrelets were among the victims of paralytic shellfish poisoning on 1 September 1989 at Pacific Rim National Park (MacBean 1989). Thousands of dead sand lance, a frequent prey of murrelets, washed ashore at that time and were highly toxic. Many gulls and at least eight sea lions also died. There are no other reports of natural mortality of this type affecting murrelets.

1.2.1.1.5 Commercial or subsistence use

There is no commercial or subsistence use of this species. There is no record of traditional harvest or cultural use by native peoples in British Columbia.

1.2.1.2 Habitat considerations

1.2.1.2.1 Overview of habitat requirements

There are marine, freshwater, and terrestrial components to the Marbled Murrelet habitat. The use of freshwater lakes does not seem to be important,

although it is regular (Carter and Sealy 1986; Hobson 1990). There does not appear to be any significant threat to the freshwater habitats.

Marbled Murrelets spend most of their lives at sea, where they feed, moult, probably perform swimming migrations, court, and copulate. The critical features of the marine habitat are: (a) an abundance of small, schooling fish, rich in oil, within the murrelet's diving depth (e.g., sand lance, juvenile herring, anchovies); and (b) security from predators or disturbance, especially during the flightless period of the autumn moult. In rich feeding areas, such as Desolation and Barkley sounds, Marbled Murrelets appear to develop a tolerance for disturbance by small boats.

The critical feature of the terrestrial habitat is the availability of suitable nest sites within range of marine foraging sites. Nests have been found up to 70 km from the sea, but most of the British Columbia breeding reports (Campbell et al. 1990) occurred within 10 km of salt water. In the southern part of the murrelet's range, all nests that have been located were in large, moss-covered, old-growth trees. In Alaska, there are records of nests on the ground in tundra and alpine areas where large trees are not available. However, the Port Chatham ground nest (710 m elevation) was above a lowland "heavily forested" with Sitka spruce (Johnston and Carter 1985). Few areas of coastal subalpine have been explored in most of the murrelet's range.

All of the breeding records for British Columbia (Campbell et al. 1990) have been associated with the southern type of habitat — stands of large old-growth trees. Five recent nest records (1990, 1991: I. Manley, pers. commun.; 1992: A.E. Burger, pers. commun.) from the Walbran and Carmanah valleys also occurred in typical coastal old growth. In 1992, two breeding birds were tracked to suspected nesting areas along Mussel Inlet, where much of the forest is classified as coastal scrub but where there are many large mossy trees.

Murrelets do not appear to use the same nest in successive years. This means that the protection of known nest sites does not guarantee protection of future sites, and that habitat quality may be related to a superfluity of suitable trees.

To date, all of the confirmed nests have been found south or north of the bulk of the population (i.e., not between 49°N and 60°N). Although there are many areas of alpine tundra and subalpine forest along the British Columbia coast that resemble similar habitats in Alaska, there is no evidence that local Marbled Murrelets will nest in such areas.

1.2.1.2.2 Status of critical habitat

Coastal old-growth forests, particularly those with large trees with moss-covered branches, appear essential in maintaining the murrelet's abundance and distribution. Such forests contain the known nest sites and most of the probable but unconfirmed breeding records in British Columbia (Campbell et al. 1990). Currently, we know neither the type nor extent of individual habitat units required to maintain a viable population of murrelets, nor do we have a method of detecting impacts of harvesting old-growth forest on murrelet populations. Reductions in the amount of nesting habitat and fragmentation of that habitat raise an array of questions about increased predation of nests, increased vulnerability of adults between the nests and the sea, edge effects and changes in the microclimate within the forest canopy, and further loss of habitat from blowdown of exposed trees.

Substantial areas of old-growth forest have been harvested, and many of the remaining areas are scheduled to be harvested within the next 20 years. The current status of old-growth forest in British Columbia is under review by the Old-Growth Task Force, which has identified several watersheds where cutting plans should consider the presence of Marbled Murrelets. The task force is also quantifying the remaining old-growth habitat.

Areas protected within parks and other reserves as well as inaccessible and nonmerchantable forest types may provide significant amounts of habitat. Conservation recommendations may include the setting aside of additional old-growth forest in areas where significant populations of murrelets are known to nest.

The coastal waters used by murrelets are protected by various federal and provincial laws. The *Canada Fisheries Act* and *Migratory Birds Convention Act* (1917) offer some legal protection by penalizing marine polluters. The *Migratory Birds Convention Act* also protects individual birds from destruction or harassment. Some marine habitats are protected within South Moresby/Gwaii Haanas National Park. The *Canada Wildlife Act* offers legislation that can be used to secure marine habitats within national or federal/provincial cooperative wildlife areas. British Columbia has established ecological reserves in some marine areas, including Checleset Bay and Robson Bight, which are of moderate importance to murrelets. However, changing the legal status of an area does little to decrease the risk from industrial accidents in the marine environment.

Portions of both the wintering and breeding populations of murrelets and their food supply are at risk from large oil spills along the outer coast and the Strait of Juan de Fuca. This threat includes all of Pacific Rim and South Moresby/Gwaii Haanas national parks, which face the route for large tankers from Alaska. The risk to Hecate Strait, Dixon Entrance, and the Strait of Georgia may increase in the future if the moratorium on petroleum exploration is lifted. The movement of oil during the *Nestucca* spill and subsequent drift block records (A.E. Burger, unpubl. data) indicate that there is some risk to the central mainland coast from large spills as far away as the mouth of the Strait of Juan de Fuca. Frequent small oil spills continue to damage Burrard Inlet, the Inside Passage, and murrelet habitat in the vicinity of small industrial sites scattered along the coast. Safety practices are constantly being updated by the Coast Guard and other regulatory bodies, but large spills remain a grave concern.

Throughout the Strait of Georgia, the murrelets face growing competition for space from mariculture, recreational boating, marinas, and coastal residential developments. A euphausiid fishery that supplies food to fish farms might eventually compete with wintering murrelets. Policy on that fishery awaits clarification of the ecological significance of local euphausiid concentrations.

1.2.1.2.3 Land use conflicts

The major conflicts between humans and murrelets over habitat are based on the harvest of old-growth forest nesting habitat and human willingness to expose the murrelets' marine habitats to the risk of industrial accidents. Small coastal developments and competition with the fisheries industry for space and food are problems that may need to be addressed in the near future. These problems also boil down to decisions on the use of shared space.

1.2.1.2.4 Effects of human activities

Pollution: There are no reported direct effects of permitted industrial or urban pollution on Marbled Murrelets, but chronic oil pollution may affect prey availability. Sand lance, one of the murrelets' preferred prey items, will not use lightly oiled sand (Pinto et al. 1984) and could be prevented from spawning on traditional beaches by petroleum products. There may also be a localized threat to fish numbers in poorly flushed and shallow inlets (e.g., Okeover Inlet) that are used for mariculture and receive untreated sewage effluent from nearby camps, villages, and unincorporated towns.

Urban development: Urban development has local effects on murrelet numbers by displacement from terrestrial habitats and disturbance or pollution of marine habitats. Around Burrard Inlet, the effects of

expanding housing areas and pollution and direct mortality from chronic oil spills in the harbour seem to have reduced the local population of murrelets (G.A. Poynter, pers. commun.). North Vancouver and West Vancouver continue to spread into potential nesting habitat, and old-growth forest in the municipal watershed is still being harvested. Recently, the annual rate of harvest was reduced to 50–60 ha, and a complete review is scheduled when the current contracts expire early in 1993.

Rural development: The construction of roads and other infrastructure associated with logging is the only form of development in rural areas that occurs on a large enough scale to have a nationally significant and long-term effect on murrelet populations. Logging itself reduces the total amount of nesting habitat available to murrelets and may affect reproductive success through habitat fragmentation, dislocation, and crowding in remnant forests.

1.2.2 The Marbled Murrelet's role in the ecosystem and interactions with humans

1.2.2.1 Ecological considerations

1.2.2.1.1 Ecological role
Marbled Murrelets usually occur in pairs or small groups and very occasionally in flocks of more than 100. Their prey items appear to be planktivorous fish and large zooplankton that often occur in dense patches. Low abundance, camouflage, and mobility may reduce the murrelet's own importance as prey to other species. Marbled Murrelets are often involved in mixed-species feeding flocks and may play an important role in the bird community by indicating the presence of food to gulls and other fish-eating birds (Kaiser et al. 1991; Mahon et al. 1992).

1.2.2.1.2 Taxonomic position
The Marbled Murrelet is one of two species in the genus *Brachyramphus* and may be either of two subspecies: *B. marmoratus marmoratus* of North America and *B. m. perdix* of Asia (Campbell et al. 1990). *B. m. perdix* is often referred to as the Long-billed Guillemot in Asian literature. Kittlitz's Murrelet *B. brevirostris* does not breed in Canada, so hybridization is not a likely problem. There is some concern in California that the remnant population will begin to show the effects of low genetic diversity. In British Columbia and Alaska, however, the population of Marbled Murrelets is too large and widespread for the reduction of genetic diversity to be an immediate concern.

1.2.2.2 Sociopolitical considerations

1.2.2.2.1 Public appeal or existence value
The Marbled Murrelet has become a symbol of the conflict between exploitation and preservation issues in the old-growth forest. Previously it was almost unknown to the general public, although it was familiar to recreational boaters and maritime workers in the Strait of Georgia. In an effort to provide public information on the species as it occurs in Canada, the Canadian Wildlife Service has produced a Hinterland Who's Who (Kaiser 1991) (Appendix 1) on this species for general distribution, and there is a comprehensive summary of occurrence data in Birds of British Columbia (Campbell et al. 1990).

1.2.2.2.2 Utilitarian value
Marbled Murrelets have no known utilitarian value. Their biology is too poorly known for them to be considered as indicators of marine environmental quality, and they appear too dispersed and vagrant to be used as monitors of toxic chemicals or heavy metals. We may learn to make use of murrelets as visible indicators of the long-term effects of our forest management practices because of their apparent dependence on old-growth forests.

1.2.2.2.3 Legal considerations
Marbled Murrelets are a "Migratory Nongame Bird" as defined by the *Migratory Birds Convention Act* (1917). The birds,

their nests, and their eggs are protected from willful damage. Migratory Bird Scientific Permits are required for any intrusive activity that disturbs a bird or its nest. Marbled Murrelets are also protected under the B.C. *Wildlife Act* and, within South Moresby/Gwaii Haanas and Pacific Rim national parks, under the *Canada Parks Act*. There is no national endangered species legislation in Canada.

Most of the terrestrial nesting habitat is provincial Crown land, but management responsibilities are assigned to various agencies as tree farm licences, timber supply areas, provincial parks or recreational areas, and ecological reserves. There are also two large national park reserves (South Moresby, Pacific Rim) managed by Parks Canada. The coastal migratory bird sanctuaries (Victoria Harbour, Esquimalt Lagoon, Christie Island) are not important to murrelets.

In 1990, the Western Canada Wilderness Committee initiated litigation to compel Environment Canada (DOE) to begin an Environmental Assessment Review (EARP) on the grounds that the Marbled Murrelet is a federal resource. DOE argued that there was no EARP trigger. The habitat is a provincial resource. The judge's subsequent decision not to issue the writ is under appeal. The *Canada Environmental Assessment Act* became law in 1992 and placed responsibility for EARP under the Canadian Environmental Assessment Agency. That agency has not yet reacted.

1.2.2.2.4 Proportion of population breeding in Canada

There are only coarse estimates of populations breeding in Alaska and British Columbia, but those two areas hold most of the species' population and typical habitat. British Columbia probably holds between 20 and 30% of the total. Less than 10% occurs farther south.

Members of the Canadian breeding population may remain in Canada throughout their life cycle and through the various seasons. Murrelets occur in all parts of the year, but there is great variability in abundance and distribution.

1.2.3 Recovery potential of Marbled Murrelet

1.2.3.1 Review of major threats and likelihood of continued threat

The single most important threat identified by Rodway (1990) was the loss of nesting habitat through the harvest of coastal old-growth forest. This threat remains the central concern for conservation of this species. No other human activity has the potential for large-scale modification of the distribution, quality, and abundance of murrelet nesting sites.

Carter and Sealy (1984) and Rodway (1990) identify by-catches in gill nets as significant causes of mortality for discrete populations of murrelets. We have been unable to find evidence of ongoing large-scale mortality. An informal poll by cooperative gill-netters who also work for conservation and management agencies (R. Burns, F. Downey, S. Forbes, L. Prestash, and M. Stewartson, pers. communs.) revealed that the problem appears to boil down to a very large number of boats, each catching an average of two or three seabirds per season (usually Common Murres *Uria aalge* or Western Grebes *Aechmophorus occidentalis* and less frequently Marbled Murrelets). Kills of 50–500 murrelets have been reported but were rare local events that occurred at night (Carter and Sealy 1984) or near Ancient Murrelet *Synthliboramphus antiquus* colonies and probably involved that species (C. Bellis, pers. commun.).

Changes in commercial salmon fishing regulations since 1984, prohibiting the use of monofilament gill nets, may have reduced this problem. By-catch of hundreds of seabirds (J. Chardine, pers. commun.) continues to be a major problem in eastern Canada and Washington, where only monofilament nets are in use. Experiments on the effect of different colours of net are under way off Newfoundland. The by-catch of murrelets in gill nets off Washington may

involve birds dispersing from British Columbia after the breeding season. This problem of by-catch in nets requires further investigation and coordination between fisheries and wildlife agencies.

1.2.3.2 Current habitat protection and recovery efforts

Tracts of coastal old-growth forest occur in Pacific Rim National Park, South Moresby/Gwaii Haanas National Park, Brooks Peninsula and Krajina ecological reserves, Strathcona, Carmanah, Naikoon, McMillan, and other provincial parks, and the Fiordland and Hakai Pass recreational areas. The value to the murrelet population of these areas in comparison to other areas along the coast is unknown.

For immediate protection and effective study, the British Columbia Ministry of Forests will establish 100-ha buffer zones around nest sites. Interim forest management recommendations (Appendix 2) have been introduced, and guidelines for significant riparian zone reserves in watersheds with Marbled Murrelets are also anticipated.

The settlement of the *Nestucca* oil spill litigation has generated a trust fund, part of which will be used to reduce the risk of damage to seabirds from oil spills. The British Columbia Environmental Emergencies Branch and Environment Canada are undertaking a new sensitivity mapping program to identify important marine habitats. Murrelets are also a major component of the avifauna within the new Coast Guard Vessel Traffic Study Areas. There are no recent inshore data suitable for the calculation of practical sensitivity ratings, and few of the historic aerial and ship surveys detected Marbled Murrelets.

The Canadian Wildlife Service plans to initiate large-scale surveys of the distribution and abundance of marine birds in 1994 as part of the Green Plan Marine Emergencies Program. Marbled Murrelets will be one of the target species in those surveys. The British Columbia Ministry of Environment, Lands and Parks and the Canadian Wildlife Service are planning to expand the coordinated coastal mapping project with resources from the *Nestucca* Trust Fund.

1.2.3.3 Degree of habitat management required

Forest management in British Columbia is intensive and controlled by an elaborate array of provincial policies and regulations. Development plans are referred to managing agencies, where guidelines have already been developed to deal with a variety of wildlife issues (e.g., fish–forestry interactions, deer and elk habitat considerations, Spotted Owl *Strix occidentalis* protection).

Interim guidelines have been developed to ensure that substantial amounts of coastal old-growth forest are retained, at least for the next five years, in watersheds believed to be important for murrelet nesting (Appendix 2). During that period, it will be essential to develop management strategies for Marbled Murrelet habitats. Those management strategies must await the results of currently planned research and inventory programs. In December 1991, guidelines for the maintenance of forest biodiversity in Tree Farm Licence areas 44 and 46 were circulated for discussion among forest managers (Appendix 2) and have led to a proposal for general guidelines applicable to the whole coastal ecosystem.

There is also an array of policies and legislation governing the industrial use of marine habitat (Coast Guard Regulations, *Canada Fisheries Act*, Ocean Dumping Regulations, *Migratory Birds Convention Act*, and the *Canada Parks Act* for the coast of Pacific Rim and South Moresby national park reserves).

1.2.3.4 Biological considerations affecting recovery

1.2.3.4.1 Recruitment rate

Recruitment rate appears to be fairly low. Murrelets lay only one egg per year and probably do not breed for the first time until three or more years of age. Young-of-the-year form only a small percentage

(usually less than 10%) of most late summer flocks, and, if they follow the pattern of other alcids, the young may suffer a high rate of winter mortality. Age structure of the population is unknown, but the frequency with which murrelets display over forests in July suggests that there is a significant nonbreeding population of adults.

1.2.3.4.2 Minimum viable population
There are no known social factors that determine a minimum viable population. The species appears to be sufficiently abundant for this not to be a consideration. However, there may be a minimum size for patches of nesting habitat. In California, birds are active in flight over stands from 10 to 790 ha (but this does not necessarily mean that breeding occurs in such blocks). The mean stand size of 130 ha and the median of 93 ha have been used to formulate interim habitat protection recommendations (Appendix 2). Isolated stands may concentrate predators and may fail to maintain a suitable climate for nesting. They are also likely to be more subject to wind damage.

1.2.3.5 Competing species/predators
Although nest sites are dispersed and well-hidden, predation appears to play an important role in reproductive success. Fragmentation of nesting habitat may be an important conservation concern, and its effects need to be determined. Concentrations of nests, use of lower quality sites, and increased percentage of edge habitat may provide greater opportunities for nest predators such as jays, crows, ravens, squirrels, and marten, which are also concentrated in the remaining stands of trees.

There are no reports of predation on murrelets at sea. The murrelet shares food items with many other seabirds and predatory fish, but there is no indication that competition for those resources is a limiting factor in population size. The prevalence of Marbled Murrelets in inlets and other areas little used by other alcids implies that they have found a specialized niche with little competition from their relatives.

Many of the seabirds that exploit schooling fish show a direct correlation between breeding success and marine habitat conditions (e.g., sea temperature). This has not been demonstrated in murrelets, but changes in distribution related to sea surface temperature and salinity suggest that it may occur (Kaiser et al. 1991).

Section 2. Setting recovery goals and objectives

2.1 Goal

Improve the status of Marbled Murrelet from threatened to vulnerable in Canada.

The conservation of Marbled Murrelets requires the preservation of sufficient nesting habitat and changes in policy to reduce risk in the marine environment. Those achievements should prevent further reductions in abundance or distribution of Marbled Murrelets in British Columbia.

2.2 Objective

Ensure effective and timely actions to protect Marbled Murrelets by reducing threats to their nesting habitat and reducing risks faced by birds at sea.

We need to dramatically improve our understanding of the biology of Marbled Murrelets and develop techniques to demonstrate the unequivocal benefits of conservation actions and changes in policy. This is best achieved by identifying nesting habitats and marine concentration areas.

Our present inability to quantify the impact of human activity on Marbled Murrelets is the real threat to their status. The achievement of this plan's goal implies the need for political decisions with broad economic and social significance. Forest habitat preservation is seen as a threat to jobs in the forest industry and a brake on the economic growth of British Columbia. New forest harvest guidelines have been endorsed by British Columbia's chief forester. If we recommend changes to those guidelines that cannot be based on sound scientific facts, we cannot expect effective political support. Similarly, we need to demonstrate the effectiveness of conservation actions that increase costs to industry.

The Marbled Murrelet is not a species for which we know how to create habitat or enhance reproductive success by artificial means. The recent discovery and description of some 20 nests in trees offer a novel opportunity for research.

At sea, we need to demonstrate that surveys and studies of marine ecology will facilitate the protection of birds during oil spills or that changes in fishing practice will reduce the risk of entanglement in nets. The *Nestucca* spill and other accidents have generated funding under the Green Plan and the *Nestucca* Trust Fund that should be used for studies that respond effectively to the conservation needs of the species.

2.3 Strategy statements

(a) Implement studies of the basic biological characteristics of Marbled Murrelets with special attention to areas where the species appears vulnerable or is likely to be affected by human activity, and fill in the gaps in knowledge that prevent the evaluation of risks or increase the uncertainty of consequences.

(b) Implement interim conservation and management plans that will slow the apparent impact of human activities on the species.

(c) Develop and recommend the implementation of new harvest guidelines for areas of coastal old-growth forest where murrelets are nesting, and protect known nest sites.

(d) Demonstrate how marine traffic safety can be improved to reduce the risk from oil spills for vulnerable species like the Marbled Murrelet.

(e) Identify important marine habitats for Marbled Murrelets and demonstrate how their abundance and distribution are an indicator of coastal resources for oil spill sensitivity mapping and other planning activities.

(f) Evaluate the importance of current losses of murrelets through by-catch in fish nets and recommend changes in procedures or regulations to reduce any threat posed by commercial fishery activities.

2.4 Narrative

2.4.1. Tactical response to the conservation issues

2.4.1.1 Filling information gaps

2.4.1.1.1 Determine population status and distribution.

2.4.1.1.1.1 Determine current distribution and relative abundance of murrelets at sea.

Preliminary surveys in 1990 indicated that Marbled Murrelets are dispersed at sea but tend to clump in certain habitats. Concentrations may be related to feeding conditions (Kaiser et al. 1991). Abundance and density usually vary daily but fluctuate strongly as fledging begins in early July (Kaiser et al. 1991). Surveys, in May and June, of inlets and coastal waters should reveal the relative abundance of birds breeding in nearby watersheds. In 1991, parts of the central coast and some inlets on Vancouver Island were surveyed (Prestash et al. 1992; J.-P.L. Savard and M.J.F. Lemon, unpubl. data). Additional small concentrations were found on the west side of Vancouver Island, and the large groups observed in Mussel Inlet and Desolation Sound in 1989 and 1990 were studied more intensively (Prestash et al. 1992; Mahon et al. 1992).

The appropriate response to this information gap is an inventory of British Columbia's coastal zone for Marbled Murrelet concentrations in various seasons. A protocol and plan for large-scale surveys of the British Columbia coast was prepared in 1994 by the B.C. Ministry of Environment, Lands and Parks.

2.4.1.1.1.2 Determine current distribution and relative abundance of murrelets in watersheds.

Field studies on Vancouver Island (A.E. Burger, unpubl. data) and on the Queen Charlotte Islands (Rodway et al. 1991) have been used to develop a survey protocol and plan for sampling several watersheds on Vancouver Island and the southern mainland. In 1991, J.-P.L.Savard and M.J.F. Lemon (unpubl. data) led a survey of many of the Vancouver Island watersheds. A.E. Burger of the University of Victoria (unpubl. data), D. Lindsay of Fletcher Challenge Canada (unpubl. data), and K. Moore (pers. commun.) followed up on those surveys with additional counts in 1992. Initial results indicate that the 1992 El Niño event coincided with qualitative, and in some areas quantitative, changes in the detections in forested areas.

A.E. Burger has completed a three-year study of bird activity in the Carmanah Creek watershed, and his analyses will have a strong effect on the design of future studies of this type. Although there is a relationship between the quantity of old-growth forest and the intensity of murrelet activity, it is not clear that these studies will help us to identify and classify habitat. The implementation of future studies of murrelet activity over watersheds will depend on demonstrations that levels of activity are directly related to nest site abundance. Habitat classification will depend on success with telemetry, radar, or breakthroughs in the interpretation of forest activity by murrelets.

2.4.1.1.2 Determine survival rates.

There are no current plans for determining survival rates or other demographic characteristics. Techniques for using mist nets have been developed (Prestash et al. 1992; G. Kaiser, unpubl. data) but are applicable only in specialized circumstances and may not allow the capture of the large samples needed for such studies without disruption of breeding effort.

Although there is little indication that drowning in gill nets continues to be a major problem, this must be confirmed before the Recovery Team can delete it from the list of important threats.

2.4.1.1.3 Examine the characteristics of migration concentrations and populations on wintering areas.

Wintering areas and postbreeding dispersal patterns are both unknown, because weather conditions have limited the quantity and quality of data collected. In winter 1992–93, the Canadian Wildlife

Service carried out a pilot study in the Strait of Georgia to identify winter concentration areas of Marbled Murrelets and to compare them to the previously described distribution of euphausiids and other prey (Mackas and Fulton 1989).

Winter concentrations of murrelets along tanker routes are vulnerable to oil spills and are a priority in the sensitivity mapping projects for coastal resources. No data for murrelets currently exist to support that kind of mapping, but some winter surveys and breeding season surveys are scheduled.

2.4.1.1.4 Determine productivity and recruitment.

Annual productivity may be indicated by the percentage of juveniles in late season flocks, but no index of reliability has been tested. The association between adults at sea and recently fledged juveniles is very loose, and the young apparently fend for themselves. Young birds rarely exceed 5% of the birds observed in an area. Recent interest in Marbled Murrelets has led to occasional second-hand reports of concentrations of juveniles in the Strait of Georgia in August. Unless there is a usable link between the distribution of adults and juveniles, it may not be possible to develop a reliable index of productivity.

Other demographic structures of the murrelet population will also be difficult to determine. The plumage of nonbreeding subadult birds is nearly identical to that of breeding adults, and separation requires capture. Birds in the hand can also be examined for brood patches, cloacal variation, and a bursa of Fabricius. The measurement of annual rate of reproductive success is not directly linked to the threats faced by murrelets and is not a high priority at this time. However, knowledge gained from capturing birds or from extended surveys may reveal unsuspected problems.

2.4.1.1.5 Carry out a periodic census.

There are no plans for replicates of annual censuses at this time, because it is unlikely that such replicates would provide information on trends in the short term. Seasonal and annual variations in abundance and distribution and responses to environmental conditions are likely to mask population trends.

Once the distribution and abundance of the regional population are clarified, monitoring changes within specific local groups will become a more useful activity. The tendency of murrelets to congregate at the heads of inlets and in shallow bays may allow the design of a simple monitoring system for use by local volunteers and agency staff with a minimum of special training.

2.4.1.2 Define habitat requirements.

2.4.1.2.1 Locate and describe nesting habitats.

Statements on the loss of nesting habitat are the most contentious in Marbled Murrelet conservation, but the issue is central to this plan. The controversy involves the relative value to murrelets of various types of coastal old-growth forest. All of the nests south of Alaska have been found in large mossy trees. Such trees are most abundant in the commercially valuable floodplain forests that are becoming increasingly rare. It is important to determine if coastal scrub forests and higher-elevation forests provide significant quantities of nesting habitat.

Several projects were under way while the recovery plan was being prepared, and, although the results have not been fully analyzed, they are already influencing future projects. A.E. Burger's (unpubl. data) intensive studies of watersheds near Carmanah Creek used behavioural observations to identify potential nesting sites. Five nests were found by searching trees near Walbran Creek. G. Kaiser (unpubl. data) developed a capture technique and examined the feasibility of using telemetry to track murrelets to nests. R. Burns and L. Prestash (unpubl. data)

attempted an operational telemetry project in Mussel Inlet in 1992 but captured only seven birds, three of which were followed to terrestrial sites. No actual nests were found. Characteristics of the likely nesting habitat, such as tree size, elevation, forest type, slope, aspect, and stand size, were recorded.

In spite of limited success with telemetry, additional attempts are planned for the west coast of Vancouver Island by R. Burns and L. Prestash (coordinated through the Council of Forest Industries). A.E. Burger plans to investigate the value of high-frequency radar as a tracking device. Although individual birds cannot be followed to nests, radar may provide more precise information on movements over forests than does visual observation. He is also planning research into the significance and interpretation of murrelet behaviour in the forest.

2.4.1.2.2 Locate and describe breeding season marine habitats.

The Marbled Murrelet conservation issue in marine habitats is not loss of habitat but human-made increases in the risks faced by foraging birds. The purpose of habitat description is to identify areas holding significant portions of the population and reduce the risks to murrelets within them. The Recovery Team may recommend changes in fishing regulations or marine traffic control. In some areas, the only option may be to identify Marbled Murrelets as a particularly sensitive coastal resource and see that it is a high priority in coastal development and oil spill contingency planning.

During boat surveys in 1990, localized murrelet concentrations were correlated with the physical characteristics of the marine environment. Concentrations tended to be associated with areas of low salinity near the heads of inlets (Kaiser et al. 1991). When surveys began in May 1991, both Desolation Sound and Mussel Inlet were warmer than expected, and there were unexpected changes in the birds' behaviour and distribution (R. Burns and L. Prestash, unpubl. data; G. Kaiser, unpubl. data). There were no significant correlations between sea temperature or salinity (G. Kaiser, unpubl. data), and there was a daily mass movement of murrelets out of Mussel Inlet near dawn during the early breeding season that would have affected the results of coastwise bird counts in the inlet (R. Burns and L. Prestash, unpubl. data). In 1992, an El Niño year with unusually warm coastal water, much smaller movements were observed (R. Burns and L. Prestash, unpubl. data). At the same time, unusually large concentrations (flocks up to 500) were detected on the east coast of the Queen Charlotte Islands (K. Moore, pers. commun.).

In the winter of 1992–93, the Canadian Wildlife Service developed and tested a protocol for small boat surveys of Marbled Murrelets that include observations of sea salinity, temperature, and plankton density. This will be followed by a systematic survey of murrelet concentration areas.

2.4.1.2.3 Locate and describe wintering habitats.

Murrelets have occasionally been found in forests in winter, but the conservation issues occur in the marine environment. Historic records (Campbell et al. 1990) indicate small numbers of wintering murrelets north of 50°N latitude, but records of any sort are sparse, and these data may reflect the distribution of observers. P.W. Martin (unpubl. data) observed 20–60 birds in the Kitkatla area (south of Prince Rupert) during January 1978.

Large groups of murrelets have been reported to winter in the Straits of Georgia and Juan de Fuca and along the southwest coast of Vancouver Island. Some of these are areas of high risk from oil spills due to tanker and barge accidents and were examined by the Canadian Wildlife Service in the winter of 1992–93.

2.4.1.2.4 Determine availability of suitable habitats.
The loss of old-growth forest, the only known suitable nesting habitat for Marbled Murrelets in British Columbia, has been identified as the critical factor in the long-term conservation of murrelets. Currently, we await information from the Old-Growth Task Force on the amount and distribution of such forest remaining in British Columbia. Observations of murrelet activity in watersheds, telemetry, and similar studies in Washington and Oregon may help to identify the range of nesting habitats in use. The industry-sponsored survey of watersheds on Vancouver Island (J.-P.L. Savard and M.J.F. Lemon, unpubl. data) and the lower mainland will be valuable in describing the relative importance of larger blocks of habitat.

2.4.1.2.5 Determine characteristics of occupied versus unoccupied habitat.
Murrelet activity over forests is the only tool currently effective in identifying likely habitat. Descriptions of habitat classes are among the anticipated products of the telemetry and radar studies discussed above.

2.4.1.2.6 Determine factors affecting habitat quality.
Current tools force us to evaluate both terrestrial and marine habitats in terms of the intensity of bird use. On land, visual and auditory detections are used in forests because nest sites are so difficult to find. At sea, we use bird densities because we are unable to interpret the significance of salinity, temperature, and plankton abundance with confidence.

The concentration of studies in coastal old-growth forest reflects the fact that all of the nests found in British Columbia, California, Oregon, and Washington and all of the likely breeding records for British Columbia (Campbell et al. 1990) have been associated with that type of habitat. The nests have usually occurred high among the moss-covered branches of very large trees. Often the nests have been shielded from view by a smaller branch deformed by mistletoe or damaged in some other way.

2.4.2 Analyze data to estimate population size, habitat, and recruitment rate required to achieve goal.

2.4.2.1 Determine a population target for Marbled Murrelets and define the criteria by which such a target is achieved or maintained.

2.4.2.1.1 Review survey results and calculate the regional population size.

2.4.2.1.1.1 Determine size and confidence limits for estimates of local populations.

2.4.2.1.1.2 Coo[illegible]rate with U.S. Fish and Wildlife Service task force in developing continental population estimates for the species.

2.4.2.1.1.3 Map seasonal concentration areas and migration routes.
The declaration that the Marbled Murrelet is an endangered species in the United States has generated interest in international cooperation to determine the continental population of the species. Dr. A.E. Burger, of the Recovery Team, has agreed to be our representative in the initial attempts to compile the available information on the species and plan the international effort.

2.4.2.2 Identify and recommend the protection of nesting habitats required by the Marbled Murrelet population.

2.4.2.2.1 Prepare a strategic plan for protection of murrelet nesting habitat.

2.4.2.2.1.1 Compare forest cover maps to murrelet nesting requirements and identify candidate areas for protection.

2.4.2.2.1.2 Encourage the development of creative approaches to habitat protection and habitat use conflict resolution.

2.4.2.2.1.3 Develop and test methods of habitat enhancement.
Habitat analysis was one of the first topics raised within the Recovery Team, and the required steps were identified at that time. However, incompatibility of data bases and uncertainty about the exact nature of the data required have hindered progress. The Recovery Team is the best-qualified group to initiate this analysis, and it should do so as a top priority.

2.4.3 Implement required actions to ensure goal is reached.

2.4.3.1 Population status

2.4.3.1.1 Develop population monitoring programs to address the issues of abundance and distribution identified as factors affecting the murrelet's status.
It will not be possible to construct population trends from the fragments of historic data; however, careful design of new surveys should allow us to estimate local populations within reasonable confidence limits. Preliminary reports indicate that the murrelet's daily and seasonal activity patterns will play an important role in the design of surveys.

2.4.3.1.2 Develop and test criteria with which to measure the effectiveness of conservation actions.
Conservation recommendations affecting access to forest resources entail significant economic impact and must be firmly grounded in good science. The effectiveness of the Recovery Team's recommendations will need to be demonstrated.

2.4.3.1.3 Include Marbled Murrelets in the development of oil spill contingency plans and the impact analysis of environmental accidents.
Marbled Murrelets were omitted from early analyses of risks to resources from oil spills because their status was not in question and their small size made them difficult to survey from aircraft. Their change in status and a deeper understanding of their vulnerability make it imperative that they be considered as a high priority in contingency planning.

2.4.3.2 Habitat conservation

2.4.3.2.1 Recommend the acceptance and implementation of the habitat conservation plan (IIB) to the government of British Columbia, which holds the lands in right of the Crown.
There are several initiatives (e.g., Valhalla Society) that identify tracts of forest that should be saved as wilderness and might offer significant habitat protection to Marbled Murrelets. The significance and effectiveness of such plans as tools for murrelet conservation can be assessed only through completion of analyses of habitat availability versus habitat requirements. The continuing loss of likely habitat in old-growth forests raises this issue to the top of all priority lists.

2.4.3.2.2 Review proposed changes in transport and fishery regulations and recommend procedures to reduce the risk to murrelets at sea.
Changing the far-reaching regulations that govern gillnetting and the transport of petroleum products is likely to have significant economic impact. The Recovery Team's recommendations must be demonstrably effective. The Recovery Team should monitor a proposal to allow the use of monofilament gill nets in the Skeena River estuary and bring conservation concerns about Marbled Murrelets to the attention of the Department of Fisheries and Oceans.

2.4.3.2.3 Review policies of resource management agencies and determine their significance to Marbled Murrelets. The British Columbia Ministry of Forests is in the midst of important policy reviews, such as the report of the Old-Growth Task Force and the development of Guidelines to Maintain Biological Diversity (Appendix 2). There are also important habitat conservation plans being developed by the British Columbia Ministry of Environment, Lands and Parks and Environment Canada. The Recovery Team should monitor these activities and take the opportunity to bring forward the needs of Marbled Murrelets.

2.4.3.3 Sociopolitical

2.4.3.3.1 Prepare a public education package that outlines the Marbled Murrelet conservation issues in plain language.

2.4.3.3.2 Develop a vehicle for public contribution to the resolution of Marbled Murrelet conservation issues. Recommendations re sociopolitical actions have not been addressed by the Recovery Team because the conservation requirements remain unclear. At this time, the basic sources of information available to the public are *Birds of British Columbia* (Campbell et al. 1990) and a Canadian Wildlife Service Hinterland Who's Who (Kaiser 1991).

2.4.3.4 Stepdown outline[1]

2.4.3.4.1. Tactical response to the conservation issues

2.4.3.4.1.1 Undertake background studies to fill information gaps.

2.4.3.4.1.1.1 Determine population status and distribution.

2.4.3.4.1.1.1.1 Determine current distribution and relative abundance of murrelets at sea.

2.4.3.4.1.1.1.1.1 Develop survey plan for Marbled Murrelets in coastal British Columbia by November 1992 (Canadian Wildlife Service) (PRIORITY 1).

2.4.3.4.1.1.1.1.1.1 Complete protocol for population surveys, including the division of coastal areas into discrete study sites by March 1993 (Canadian Wildlife Service).

2.4.3.4.1.1.1.1.1.2 Ensure that the data records are compatible with the requirements of the British Columbia Conservation Data Centre before surveys are initiated (Canadian Wildlife Service).

2.4.3.4.1.1.1.1.1.3 Establish methodology for collecting and recording plankton densities, surface salinities and temperatures, depths, and other significant marine data during surveys by January 1993 (Canadian Wildlife Service).

2.4.3.4.1.1.1.1.1.4 Review proposals for surveys of Marbled Murrelets in Alaska and other parts of the United States and adjust methodology to ensure compatibility by March 1993 (Canadian Wildlife Service).

2.4.3.4.1.1.1.1.2 Initiate seasonal surveys of Marbled Murrelets to develop reliable estimates of abundance and map seasonal concentrations (Canadian Wildlife Service) (PRIORITY 1–2).

2.4.3.4.1.1.1.1.2.1 Initiate winter surveys of murrelets in the Strait of Georgia and test marine habitat description methodology by March 1993 (Canadian Wildlife Service $20 000).

[1] For definitions of priority levels given in this section, refer to section 3.

2.4.3.4.1.1.1.1.2.2 Review Marbled Murrelet surveys carried out in the Queen Charlotte Islands and bring methods in line with standard methodology by April 1993 (Parks Canada).

2.4.3.4.1.1.1.1.2.3 Complete Marbled Murrelet inventory of southeast Moresby Island by July 1994 (Parks Canada — 2 years @ $20 000 each).

2.4.3.4.1.1.1.1.2.4 Complete surveys of Marbled Murrelets along shipping routes during the breeding season by August 1996 (Canadian Wildlife Service — 4 years @ $40 000 each).

2.4.3.4.1.1.1.2 Determine current distribution and relative abundance of murrelets in watersheds (PRIORITY 2).

2.4.3.4.1.1.1.2.1 Develop criteria for relating murrelet activity over forests to nesting habitat value.

2.4.3.4.1.1.1.2.1.1 Review results of studies completed in British Columbia and compare them with reports from Washington, Oregon, and California to determine the value of additional studies involving visual observations of murrelet activity by February 1993 (Recovery Team).

2.4.3.4.1.1.1.2.1.2 Test high-frequency radar as a tool for following birds over forests and determining probable destinations by August 1993 (A.E. Burger, Univ. of Victoria — $20 000).

2.4.3.4.1.1.2 Determine survival rates.

2.4.3.4.1.1.2.1 Improve and refine capture techniques (PRIORITY 2).

2.4.3.4.1.1.2.1.1 Test improved designs of mist net arrays and attempt to reduce their sensitivity to wind and current by June 1993. Improved capture techniques are required for the initiation of other Priority 1 projects (Canadian Wildlife Service/Parks Canada — $8000).

2.4.3.4.1.1.2.1.2 Select discrete groups of murrelets where capture/recapture techniques might be feasible by March 1994 (Canadian Wildlife Service).

2.4.3.4.1.1.2.2 Develop proposals for a feasible survival rate study by March 1994 (Canadian Wildlife Service) (PRIORITY 3).

2.4.3.4.1.1.2.3 Evaluate loss of murrelets in fishing nets (British Columbia Ministry of Environment, Lands and Parks) (PRIORITY 1).

2.4.3.4.1.1.2.3.1 Determine the scope of the current problem through a systematic poll of fisheries officers, conservation officers, park wardens, and fishermen's groups by September 1994 (British Columbia Wildlife Branch/Department of Fisheries and Oceans — $5000).

2.4.3.4.1.1.3 Examine the characteristics of migration concentrations and populations on wintering areas (PRIORITY 2).

2.4.3.4.1.1.3.1 Design and implement a nonbreeding season survey for Marbled Murrelets.

2.4.3.4.1.1.3.1.1 Identify winter concentrations and areas at high risk from oil spills by September 1996 (Canadian Wildlife Service — 4 years @ $20 000 each).

2.4.3.4.1.1.3.1.2 Test applicability of long-lived radio packs with satellite links to follow postbreeding birds to moulting areas (Canadian Wildlife Service — $40 000).

2.4.3.4.1.1.4 Determine productivity and recruitment (PRIORITY 3).

2.4.3.4.1.1.4.1 Review progress in the study of Marbled Murrelets annually, and re-examine the feasibility of studying productivity and recruitment (Recovery Team).

2.4.3.4.1.1.5 Carry out periodic census and other projects to measure real changes in the population (PRIORITY 3).

2.4.3.4.1.1.5.1 Design a periodic census that accommodates variance in observer acuity, changes in habitat values, variations in the murrelets' behaviour, variations in phenology, etc.

2.4.3.4.1.1.5.1.1 Review progress in the study of Marbled Murrelets annually, and reevaluate the use of a periodic census as a tool for measuring real change in the population (Recovery Team).

2.4.3.4.1.2 Define habitat requirements.

2.4.3.4.1.2.1 Locate and describe nesting habitats (PRIORITY 1).

2.4.3.4.1.2.1.1 Provide a clear description of the forest types currently available as nesting habitat to Marbled Murrelets (British Columbia Ministry of Forests).

2.4.3.4.1.2.1.1.1 Prepare a map of old-growth forests in the coastal zone (Old-Growth Task Force/British Columbia Ministry of Forests).

2.4.3.4.1.2.1.1.2 Complete the report on murrelet activity in Vancouver Island watersheds by March 1993 (Canadian Wildlife Service).

2.4.3.4.1.2.1.1.3 Identify the quantity of potential nesting habitat for Marbled Murrelets currently contained in national and provincial parks by March 1995 (Parks Canada/ British Columbia Ministry of Land, Environment and Parks — $40 000).

2.4.3.4.1.2.1.2 Identify Marbled Murrelet nesting habitats.

2.4.3.4.1.2.1.2.1 Implement telemetry studies in selected inlets by May 1993 (coordinated by the Council of Forest Industries, $160 000 invested in 1991 and 1992).

2.4.3.4.1.2.1.2.2 Test high-frequency radar as a method of tracking bird movements over forests (A.E. Burger, Univ. of Victoria — $30 000).

2.4.3.4.1.2.2 Locate and describe breeding season marine habitats (PRIORITY 2).

2.4.3.4.1.2.2.1 Develop a protocol for recording habitat characteristics as part of surveys for coastal concentrations by March 1993 (Canadian Wildlife Service).

2.4.3.4.1.2.2.1.1 Design a data record that is compatible with the requirements of the British Columbia Conservation Data Centre.

2.4.3.4.1.2.2.1.2 Field test the data record system by March 1993.

2.4.3.4.1.2.3 Locate and describe wintering habitats (PRIORITY 3).

2.4.3.4.1.2.3.1 Develop and implement a protocol for recording habitat characteristics as part of surveys for coastal concentrations (Canadian Wildlife Service).

2.4.3.4.1.2.4 Determine availability of suitable habitats (PRIORITY 2).

2.4.3.4.1.2.4.1 Review the product from projects described above and develop further studies and criteria for designation of critical and important habitats by January 1994 (Recovery Team).

2.4.3.4.1.2.4.2 Actions will be recommended to the appropriate authorities for securing nesting and marine habitats required for the conservation of the species (Recovery Team).

2.4.3.4.1.2.5 Determine characteristics of occupied versus unoccupied habitat (PRIORITY 3).

2.4.3.4.1.2.5.1 Test habitat classification criteria by comparing occupancy of apparently similar areas by 1997 (Canadian Wildlife Service — $40 000).

2.4.3.4.1.2.6 Determine factors affecting habitat quality (PRIORITY 2).

2.4.3.4.1.2.6.1 Develop habitat classification criteria based on the results of coastal surveys and searches for nesting habitat by 1994 (Recovery Team).

2.4.3.4.1.2.6.2 Test influence of old-growth stand size and other factors that likely influence nesting density and predation rates by 1994 (British Columbia Forest Service/Canadian Wildlife Service — 2 years @ $50 000).

2.4.3.4.2 Analyze data to estimate population size, habitat, and recruitment to achieve goal.

2.4.3.4.2.1 Determine a population target or abundance criteria that will indicate status of the species.

2.4.3.4.2.1.1 Review survey results and calculate regional population size.

2.4.3.4.2.1.1.1 Determine size and confidence limits for estimates of local populations (Recovery Team) (PRIORITY 1).

2.4.3.4.2.1.1.2 Cooperate with U.S. Fish and Wildlife Service task force in developing continental population estimates for the species (Recovery Team) (PRIORITY 1).

2.4.3.4.2.1.1.3 Map seasonal concentration areas and migration routes (British Columbia Ministry of Environment, Lands and Parks) (PRIORITY 2).

2.4.3.4.2.2 Identify and recommend the protection of nesting habitats.

2.4.3.4.2.2.1 Prepare a strategic plan for protection of murrelet nesting habitat.

2.4.3.4.2.2.1.1. Compare forest cover maps to murrelet nesting requirements and identify candidate areas for protection (Recovery Team) (PRIORITY 1).

2.4.3.4.2.2.1.2 Encourage the development of creative approaches to habitat protection and habitat use conflict resolution (Recovery Team) (PRIORITY 2).

2.4.3.4.2.2.1.3 Develop and test methods of habitat enhancement (Recovery Team) (PRIORITY 3).

2.4.3.4.3 Implement actions required to meet the recovery plan goal.

2.4.3.4.3.1 Changing the population status

2.4.3.4.3.1.1 Develop population monitoring programs to address the issues of abundance and distribution identified as factors affecting the murrelet's status (Recovery Team) (PRIORITY 2).

2.4.3.4.3.1.2 Develop and test criteria with which to measure the effectiveness of conservation actions (Recovery Team) (PRIORITY 2).

2.4.3.4.3.1.3 Ensure that Marbled Murrelets are considered in the development of contingency plans for environmental emergencies and in the impact analysis of major oil spills and other accidents (Canadian Wildlife Service) (PRIORITY 1).

2.4.3.4.3.2 Ecological actions

2.4.3.4.3.2.1 Recommend the acceptance and implementation of the habitat conservation plan (IIB) to the government of British Columbia, which holds the lands in right of the Crown (Recovery Team) (PRIORITY 1).

2.4.3.4.3.2.2 Review proposed changes in fishery and petroleum transport regulations and policies and recommend procedures that will reduce the risk to murrelets at sea (Recovery Team) (PRIORITY 1).

2.4.3.4.3.2.3 Review the policies of resource management agencies (e.g., Guidelines to Maintain Biological Diversity) and report on their significance to murrelet conservation (Recovery Team) (PRIORITY 1).

2.4.3.4.3.3 Sociopolitical actions

2.4.3.4.3.3.1 Prepare a public education package that outlines the Marbled Murrelet conservation issues in plain language (Recovery Team) (PRIORITY 3).

2.4.3.4.3.3.2 Develop a vehicle for public contribution to the resolution of Marbled Murrelet conservation issues (Recovery Team) (PRIORITY 2).

3. Implementation schedule

The implementation schedule (Table 1) lists recovery actions outlined in the recovery plan and identifies their priorities, time frame, costs, and the agencies responsible for carrying them out. Priorities for these actions are defined as follows:

Priority 1: An action that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery (or status improvement) of the species.

Table 1. Implementation schedule for the National Recovery Plan for the Marbled Murrelet

Event*	Topic	Lead agency	Priority	Cost	Start date	Duration	Operation	Funding source
2.4.1.1.1.1	Abundance at sea	CWS	1	$ 15 000	May 1991	1990 spring	Preliminary survey along the central coast (Kaiser et al. 1991)	CWS
		CWS	2	$ 18 000	Jan 1993	1993 winter	Locate concentration areas in Str. of Georgia.	Green Plan
		PC	2	$ 80 000	Jan 1990	1989–1994 summer	Surveys of southeast Moresby Is.	PC/CWS
		CWS/BCMELP	1	$360 000	May 1993	1993–1996 4 seasons	Identify seasonal concentration areas along the coast.	Nestucca Trust Fund/Green Plan
2.4.1.1.1.2	Abundance in watersheds	BCMOF/CWS	2	$ 55 000	May 1990	1990	Survey of Queen Charlotte Is. (Rodway et al. 1991)	BCMOF/CWS
		CWS/Ind. coop.	2	$100 000	May 1991	1991	Survey of Vancouver Is. watersheds (J.-P.L. Savard and M.J.F. Lemon, unpubl. data)	CWS/Industry cooperators
		A.E. Burger	2	$ 85 000	May 1990	1990–1993	Activity patterns and habitat use in the Carmanah Valley	WWF/WCWC/ various
2.4.1.1.2.1	Capture techniques	CWS	2	$ 22 000	May 1991	1991	Design and test mist net system. (Prestash et al. 1992).	CWS
		various	2		1991	ongoing	Select and evaluate study areas for telemetry, etc.	Recovery Team
2.4.1.1.2.2	Survival rates	CWS	3		1994	-	Develop study proposals.	Recovery Team
2.4.1.1.2.3	Fishery interactions	BCWB	1	$ 5 000	1993	1993	Interview a sample of fishery workers.	BCWB
2.4.1.1.3.1	Wintering concentrations	CWS	2	$ 80 000	1996	1996–1999	Determine stability of winter concentrations.	CWS
		CWS	2	$ 40 000	1995	1995	Test long-life transmitters and satellite telemetry.	CWS
2.4.1.1.4.1	Recruitment or reproduction rates	Recovery Team	3		ongoing	-	Evaluate potential for determining population parameters.	Recovery Team
2.4.1.1.5.1	Population changes	CWS	3		ongoing	-	Evaluate use of periodic surveys to detect changes in populations.	CWS
2.4.1.2.1.1	Habitat availability	BCMOF	1		1991 1991 1995	1991–199? 1992–93 1995	(i) Map old-growth forests. (ii) Analyze activity in the Vancouver Is. watersheds. (iii) Quantify habitat in protected areas.	BCMOF CWS BCMELP/PC

Table 1. Implementation schedule for the National Recovery Plan for the Marbled Murrelet (continued)

Event*	Topic	Lead agency	Priority	Cost	Start date	Duration	Operation	Funding source
2.4.1.2.2.1	Summer flocks near breeding areas	CWS	2		1995	-	Examine relation between at-sea groups and nesting areas.	CWS
2.4.1.2.3.1	Winter activity in forests	CWS	3		-	-	Evaluate significance of activity in forest areas in the winter.	CWS
2.4.1.2.4.1	Habitat suitability	Recovery Team	2		1993	1993–1994	a. Develop criteria for designating critical habitats.	Recovery team
				$350 000	1990	1990–1994	b. Identify nesting areas by telemetry.	Industrial/ government coop
		A.E. Burger	2	$50 000	1993	1993–1994	c. Test high-frequency radar as a tracking tool.	WWF/ESRF
2.4.1.2.4.2	Habitat protection	Recovery Team	2		1993	ongoing	Identify potential candidate areas for protection.	Recovery Team
2.4.1.2.5.1	Habitat selection	CWS	3	$40 000	1996	1996–1997	Compare occupied and unoccupied "nesting" habitats.	Recovery Team
2.4.1.2.6	Habitat quality	BCMOF	2	$100 000	1994	1994–1995	Develop habitat classification scheme; relate old-growth stand size to murrelet nesting density.	BCMOF
2.4.2.1.1.1	Local population levels	Recovery Team	1		1996	1996	Determine population size and confidence limits of estimates.	Recovery Team
2.4.2.1.1.2	Continental population levels	Recovery Team	1	$ 2 000	1993	1993–1996	Cooperate with USFWS efforts to determine continental population level.	Recovery Team
2.4.2.1.1.3	Population distribution	BCMELP	2		1993	1993–1999	Map seasonal concentrations and possible migration areas as part of risk analysis.	BCMELP
2.4.2.2.1.1	Regional conservation strategy	Recovery Team	1		1995	1995	Identify forest areas important to Marbled Murrelets in B.C.	Recovery Team
2.4.2.2.1.2		Recovery Team	2		ongoing	ongoing	Encourage creative approaches to habitat protection and conflict resolution.	Recovery Team
2.4.2.2.1.3	Habitat enhancement	Recovery Team	3		ongoing	ongoing	Evaluate opportunities for habitat enhancement.	Recovery Team
2.4.3.1	Monitoring progress	Recovery Team	2		ongoing	ongoing	1. Upgrade population studies from a series of surveys to a population monitoring program.	Recovery Team
			2				2. Develop tests of the effectiveness of conservation actions.	Recovery Team
			1				3. Ensure awareness of murrelet conservation issues in risk analysis for coastal areas.	Recovery Team

Table 1. Implementation schedule for the National Recovery Plan for the Marbled Murrelet (continued)

Event*	Topic	Lead agency	Priority	Cost	Start date	Duration	Operation	Funding source
2.4.3.2	Ecological actions	Recovery Team	1		ongoing	ongoing	1. Recommend acceptance and implementation of the habitat conservation plan (IIB).	Recovery Team
							2. Recommend actions to reduce risks to murrelets at sea.	Recovery Team
							3. Monitor policies and regulations of management agencies for impact on murrelets.	Recovery Team
2.4.3.3	Sociopolitical actions	Recovery Team	3		ongoing	ongoing	Improve the public information and consultation opportunities on murrelet issues.	Recovery Team
2.4.4	Total cost			$1 402 000			Estimated value of identified expenditures 1990–1999.	

* The event number corresponds to the number for the action in the narrative. To find the action in the stepdown outline simply insert 3 and 4 as the third and fourth digits.

BCMELP = British Columbia Ministry of Environment, Lands and Parks.
BCMOF = British Columbia Ministry of Forests.
BCWB = British Columbia Wildlife Branch.
CWS = Canadian Wildlife Service.
ESRF = Endangered Species Recovery Fund.
Ind. coop. = independent cooperators, not attached to a governmental or nongovernmental organization.
PC = Parks Canada.
USFWS = U.S. Fish and Wildlife Service.
WCWC = Western Canada Wilderness Committee.
WWF = World Wildlife Fund (Canada).

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Appendix 1

Account of the Marbled Murrelet, reproduced from the Hinterland Who's Who pamphlet on the species (Kaiser 1991).

What is the most mysterious bird on the Pacific coast of Canada? The title clearly belongs to the Marbled Murrelet *Brachyramphus marmoratus*. This species nests on the mainland in almost total obscurity, although people who fish and boat along the British Columbia coast during spring and summer (when the birds are nesting) often see Marbled Murrelets out on the water. Amazingly, in the 200 years that the species has been known to science, observers in British Columbia have seen only one occupied nest, in 1990. The story is the same over the whole of the murrelet's North Pacific range; to date, there are just over a dozen recorded sightings of occupied nests from Canada, Japan, the U.S.S.R., and the United States.

Now this secretive seabird is endangered by human activities. In 1990, the Marbled Murrelet was added to the list of "threatened" species prepared by the Committee on the Status of Endangered Wildlife in Canada. It is likely that Marbled Murrelet populations need extensive old growth forest for nesting, and most of this forest is slated for logging.

Appearance

The Marbled Murrelet is completely unspectacular, with no fancy facial plumes or colourful bill ornaments. Like many other birds, this murrelet grows two sets of feathers each year, and, like some of those other birds, its summer and winter plumages are quite different. The summer plumage is "marbled" in shades of brown, mostly dark. The winter feathering is black and white, similar to that of the more numerous Ancient Murrelet; however, white shoulder patches and a white throat distinguish the Marbled Murrelet.

Marbled Murrelets come ashore only during the breeding season, to lay and incubate the egg and to feed the nestling. In the forest, their brown plumage makes them hard to spot. And the bird's habit of only coming off the water under cover of darkness makes sighting a Marbled Murrelet even more of a challenge to land-based observers.

At sea, the Marbled Murrelet is not hard to spot, although it is wary and will quickly dive away from boats that approach too closely. Summer boaters know it as a small brown bird that swims with its pointed bill tipped up in the air. When it flies, the small wings beat very fast to lift the plump body, and the bird zigzags low over the water like an oversized bumblebee.

The murrelet is well adapted for life on the sea and especially under it. The feathers are unusually thick and dense to keep out the cold. The feet are webbed like a duck's, but very small, and are used for propulsion only when the bird swims on the surface. Underwater, the feet steer the bird, and it is propelled forward by its powerful "flippers," the same stubby wings that must work so hard to keep the bird in the air. The murrelet "flies" underwater. The bill is well designed for seizing slippery fish with a firm grip.

Range and status

Marbled Murrelets occur in Asia around the Sea of Okhotsk, in Alaska, and along the Pacific coast of North America, as far south as northern California. In North America, the normal range of the birds is within 70 km of salt water, west of the coastal mountains.

Biologists have roughly estimated the B.C. population at 40 000–50 000. To determine how much nesting habitat the species needs, scientists must learn more about its nesting habits. No one is sure exactly where most Marbled Murrelets nest; however, thousands of birds spend the summer on the coast, many adults have been seen carrying food inland at this time, and 14 nestlings have been found in forests and on land far from the sea. There is no indication that Marbled Murrelets nest in colonies, but this possibility cannot yet be ruled out.

Throughout the murrelets' North Pacific range, most occupied nests have been found

in tall trees. They were simple cups in the moss on thick branches, 20–40 m above the ground. Only fairly old Douglas fir and Sitka spruce have branches thick enough for murrelet nests, although other trees may offer suitable platforms or cavities. (Nesting murrelets have used hemlock in the state of Washington and larch in the Okhotsk region of the U.S.S.R.) In treeless parts of Alaska, nests have been reported from the open tundra and at the top of a scree slope (a slope covered in loose stones).

Trees with thick branches near the top usually occur in stands of old growth and mature forests that are rapidly being cut for timber. If it turns out that British Columbia's murrelets are not concentrated in colonies and have no alternative nesting habitat, the need to protect sites for murrelet nests will be another reason to preserve more of B.C.'s coastal old growth forests. However, a great many areas still remain to be explored for nests. Nests found on the ground in Alaska show that murrelets in that area have alternative nesting strategies. Perhaps the Canadian population does, too.

Feeding

Catching fish takes up most of the murrelets' time. Most often the birds dive well below the surface and swallow fish underwater. Sometimes a murrelet will drive a dense school of fish to the surface and keep it there as long as possible with shallow dives. During the shallow dives, the murrelet will pick off and eat individuals one at a time. The swarms of small fish boiling at the surface will attract other murrelets and gulls eager for easy pickings.

The murrelets adapt their dives to the fish available. In the south, sand lance are attacked in small channels and inlets where they are concentrated by tidal currents. In the north, herring seem to be caught most easily against steep cliffs in the deep inlets. The murrelets also feed on northern anchovy. In May and June, small fish are so widespread that murrelets can fish almost anywhere and spend much of the day preening and dozing. Later, as waters warm up in the summer, fish become more scarce, and the murrelets concentrate their efforts at the richest areas, such as tidal rapids. If fish are unusually plentiful, more than 100 murrelets may gather in a flock.
No one has measured the depth to which Marbled Murrelets can dive, but similar-sized relatives, such as the Cassin's Auklet, reach 43 m and more. The murrelet uses mostly short dives, which last less than 30 seconds. Often, after a series of dives, it will flap its wings vigorously. This fluffs the plumage and restores the insulating effect of the feathers. A brief splashing bath usually marks a successful fishing effort.

Breeding season

The annual cycle for Marbled Murrelets begins in April, when the winter storms start to abate.

There is no distinct migration wave. The population slowly spreads northwards from wintering areas and moves, at the same time as the favourite prey, juvenile Pacific herring and Pacific sand lance, into the coastal inlets and bays. The long inlets that cut into the B.C. coast also bring the birds closer to the forests in which most seem to nest.

Nesting begins in May when the female lays a single large egg. For about one month, each adult takes daylong turns at incubation. The adults use off-duty days to fatten up on fish and get ready for the next shift on the nest. The first eggs hatch in June, and the life of the parent birds becomes hectic. Every night for about a month, each parent carries a meal to the nest, which may be as far as 70 km from the sea. The timing of the flights, after dark, helps the parent birds to avoid predators, such as Peregrine Falcons, and to avoid leading nest raiders, such as ravens, crows, and jays, to the nest. The meals usually consist of a single fish about 15 cm long that the murrelet can carry crosswise in its bill. Slightly larger fish are carried with the head down the bird's throat and the tail protruding from its mouth.

Young murrelets begin to appear in coastal waters at the end of June but are not numerous until late July. They are quite distinctive in the black-and-white plumage

that the adults will also adopt for the winter months. They are completely independent of their parents as soon as they fly from the nest, but often join other adult birds in good feeding areas.

Migration

Many murrelets forage in the inlets through the fall, but, at some point, worsening weather and decreasing food supplies combine to force their departure. Some of the northern inlets and those farthest inland freeze over, forcing the murrelets out. Elsewhere, the herring grow too large for murrelets to take, and the sand lance burrow into the ocean bottom for their winter dormant period. Many Marbled Murrelets join large flocks of Ancient Murrelets in the straits of Georgia and Juan de Fuca for the winter. The flow of nutrients out of the Fraser River estuary makes the straits a very rich habitat for many organisms. The wintering grounds for the bulk of the population remain a mystery.

Causes of death

Adult murrelets are believed to live as long as 25 years because there are few natural threats in their environment. They are occasionally attacked by Bald Eagles and Peregrine Falcons and perhaps by seals and sea lions, but they are not a regular part of any predator's diet.

Human activities can have a serious effect on the population. Even small oil spills can wipe out significant portions of the Canadian population, because that population is small and often concentrated, especially in winter when the birds congregate to take advantage of scarce food supplies. Fortunately, many of the important summering areas for murrelets are in small inlets, well away from tanker routes.

Recently, concern has been raised about the number of murrelets drowned in gill nets. In Barkley Sound, on the west coast of Vancouver Island, 200 birds were killed in one season. This is more than the number of young murrelets produced in that area. Fortunately, gillnetting is the only form of fishing that interferes with the murrelets, and it is not used extensively in the important breeding areas at the heads of inlets. In Barkley Sound, the problem area is fairly small and it may be possible to develop regulations to protect the murrelets using it. The overall importance of losses to fish nets still needs to be examined in important murrelet concentration areas near Bella Bella and off the southern Queen Charlotte Islands.

Conservation

Conservation of the Marbled Murrelet must begin with protection of its nesting habitat. Recently, observers have been trying to identify areas used by nesting murrelets by listening for calls in the coastal rainforests. They have located several sites where there is a lot of activity for an hour on each side of sunrise. Some of the murrelets circle high up, uttering a charecteristic "keer-keer" that sounds a little like the call of a gull. Occasionally, they make a peculiar "jetplane" noise by allowing air to rush through their feathers. Others are completely silent, and only their silhouettes are visible against the lightening sky. Murrelets have been seen landing in and leaving some large trees. This is how the solitary confirmed B.C. nest was found in 1990 on the west side of Vancouver Island.

Biologists are also planning to attach tiny radio transmitters to the birds to pinpoint nest sites. The transmitters weigh less than a dime and will be attached to birds captured on the water at the beginning of the breeding season. They will allow scientists to trace the birds' movements for about six weeks. Because the transmitters will be attached to the birds' feathers, they will fall off when the murrelets moult at the end of the breeding season.

Every new season brings important discoveries about Marbled Murrelets, and our understanding of the species is increasing rapidly. Most of the effort must be put into the search for nest sites so that breeding habitat can be protected; however, biologists also need to look carefully at oil spills, gillnetting, and the expansion of marinas and fish farms. If the Marbled

Murrelet gives up enough of its secrets, conservation questions will have easier answers.

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Appendix 2

Forest management guidelines prepared for the British Columbia Ministry of Forests with reference to the conservation of Marbled Murrelets

Interim forest management
recommendations
to conserve marbled murrelet nesting
habitat
in coastal British Columbia
January 29, 1991

Interim recommendations to protect marbled murrelet nesting habitat in areas identified for special consideration by the Old Growth Strategy Project.

Background:

1. Marbled murrelets are currently classified as a threatened species in Canada, in part because it appears that the birds may be dependent on old growth forests for nesting habitat.
2. Marbled murrelets are currently abundant and probably nest in most watersheds in coastal British Columbia, although further surveys are required. Given the current abundance and distribution of the birds, the rate of forest harvesting and the amount of old growth forest left in coastal British Columbia, the survival of the species is not imminently threatened by logging, but could be in the future.
3. The birds will nest in partially harvested watersheds if suitable stands of old growth habitat remain. Therefore, the mere presence of marbled murrelets in a watershed during the nesting season does not justify a total moratorium on logging for the entire watershed. However, the abundance of the species could be affected in local areas if all suitable habitat was lost.
4. Marbled murrelets appear to require mossy platforms in the branches of large conifer trees for nesting. At this time, we do not know what types of old growth stands are preferred for nesting. Nests and nesting activity have been detected in a wide range of elevations and old growth forest types. Therefore, until we are able to conduct additional research to determine nesting habitat requirements, it would be prudent to maintain suitably sized stands of old growth forest spanning the entire range of elevations in watersheds that are used by marbled murrelets for nesting. Special attention should be given to maintaining valley-bottom old growth stands because those stands have larger trees which may be preferred by murrelets and valley-bottoms are the areas where old growth is being liquidated most rapidly.
5. Research in Oregon detected marbled murrelet nesting activity in stands ranging from 10 to 400 ha in size with a median size of 93 ha.

Recommendations:

Until additional information is collected on nesting habitat requirements, in watersheds where marbled murrelet nesting habitat is a concern:

1. Retain corridors of old growth forest from valley bottom to the height of land. Corridors should be 400–600 m wide, could follow streams, and would provide contiguous habitat blocks of a size known to be sufficient to support marbled murrelet nesting activity. The corridors should serve as leave areas between cutblocks.
2. Retain a streamside corridor in the valley bottom of about 300 m in width.
3. Encourage logging at mid and upper elevations rather than in valley bottoms wherever possible.
4. In watersheds with limited valley bottom old growth forest remaining, deferral of new harvesting should be considered.

These recommendations will ensure that a substantial amount of old growth forest remains available over the entire range of elevations to provide nesting habitat during

the next five years during which time research can proceed on the nesting habitat requirements.

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Guidelines to maintain biological diversity in TFL #44 and TFL #46

December 1991

Introduction

The Ministry of Forests and the Ministry of Environment, Lands and Parks are mandated to carry out integrated resource management. Fundamental to integrated resource management is an understanding of how to manage for biological diversity (biodiversity).

In recent reviews of TFL 44 and 46 one of the most commonly expressed concerns of the public was how the management for biodiversity is being addressed in the management and working plan. These guidelines are a first approximation at addressing biodiversity concerns (within TFLs 44 and 46) at the landscape level.

Definition of Biodiversity

A commonly accepted definition of biodiversity is:

The diversity of life in all its forms and levels of organization and includes genes, species, and ecosystems.

TFL 44 and 46 are located in a complex area in terms of its climate, geology, ecology and past harvest and land use activity.

These guidelines are designed to ensure that all life processes and native organisms within the management units are recognized and maintained. Management for biodiversity is essential if we are to maintain a healthy environment and provide for the needs of current and future generations.

Context and Application

These guidelines are intended to be used by forest management planners. They are intended to be implemented in conjunction with existing and proposed resource managment strategies and guidelines.

The management of biodiversity on TFLs 44 and 46 occurs at three levels; management unit (TFL); landscape unit (generally expressed as a watershed from 5 000 to 20 000 hectares in size); and the stand level. Since these guidelines are intended for the planning process, they will only address the first two levels. The successful management of biodiversity must include all three levels. At the stand level this would include management of biodiversity through Pre-Harvest Silviculture Prescriptions, harvesting, reforestation and stand tending activities.

Biodiversity Goals for the managed landscape:

- ecosystem based management;
- an inventory of resources;
- retention of stands with old growth attributes;
- a variety of age classes;
- a variety of native organisms including tree species;
- protection of rare and special species and habitats;
- a range of structural and spacial diversity;
- networks of forests connecting protected areas;
- a range of opportunities for societal use;
- a spectrum of forest practices including a variety of opening sizes and harvesting systems.

Although these are the optimum goals they may not be achievable on an individual landscape unit because of past harvest patterns and natural disturbances. Where these goals are not achievable, there may be various stand level practices that may be considered to enhance biodiversity.

These guidelines employ two concurrent components towards meeting the objectives. The first is a forest ecosystem network incorporating protected area and linkages. Within the remainder of the landscape, general conditions are prescribed to focus plans on large scale habitat diversity, again at the landscape level. As well, these guidelines provide considerations for the management of biodiversity at broad (Management Unit, Regional, Provincial) planning levels.

The objective is to develop a biodiversity plan for each landscape unit. These plans will then be amalgamated to develop

biodiversity plans for management units and regions.

1. Forest Ecosystem Network Component

Goal

The goal of a Forest Ecosystem Network is to maintain a protected forest network of old-growth and special ecosystems in their natural state with sufficient distribution and size to ensure that their ecological integrity is sustained.

The goal will be accomplished through a 3-step process:

1. Designation of protected areas.
2. Provision of forested linkages between protected areas.
3. Ensuring ecosystem representation in the network.

Process

1. Designation of protected areas.

Designation of the protected areas requires 3 steps:

a. Identify and map unmerchantable and inoperable timber.
b. Identify and map special habitats, including:
   i. Environmentally Sensitive Areas.
   ii. Special habitats not represented in ESA's (e.g. wetlands)
   iii. Streamside management areas, and;
   iv. Areas reserved for other purposes (e.g. recreation).
c. Identify and map additional areas required to meet broader scale objectives (Refer to Section 3- "Broad Planning Considerations For Biodiversity")

Protected areas are intended to remain as permanent components of the Forest Ecosystem Network. These areas should be of sufficient size to maintain "interior" forest conditions (i.e. with microclimate largely unaltered by surrounding non-forested areas). The recommended minimum dimension for protected areas is 400 m.

2. Provision of forested linkages between protected areas

The intent is, where possible, to link protected areas into networks of functional ecosystems. This process should include linkages between riparian zones and upslope to higher elevation blocks. Protected areas and forested linkages should be distributed within the drainage to represent all biogeoclimatic variants. Forested linkages should also have the following characteristics:

a. Linkage elements of the network may be replaced over time with other suitable areas functioning as mature forests (60+ years).
b. Linkages should be of sufficient width to provide interior forest habitat, with buffers (as required) to remain windfirm.

3. Ensuring ecosystem representation in the network

The intent is to ensure that the network created in steps 1 and 2 represents all site series (ecosystem associations) present in the watershed. Rarer ecosystems must be over-represented (on a percentage basis) in the network. Ideally a minimum of 10% of any site series should be represented.

Where information on site series distribution is unavailable, other information (e.g. timber type, site class, soil maps) should be utilized.

Establishment of a Forested Ecosystem Network is the first component of these Biodiversity Guidelines. The next section describes the second component, management of areas outside of the Forest Ecosystem Network.

2. Large Scale Habitat Diversity Component

The second component of the Biodiversity Guidelines is to provide a well-distributed variety of habitats on the areas outside the Forest Ecosystem Network. Current Coast

Planning Guidelines encourage a distribution of age classes throughout forested elevations. To help ensure biodiversity is maintained, both early seral stages with a strong understorey component (commonly 0–15 years) and later seral stages as the mature canopy opens (commonly 60+ years) must be present. To meet this broad objective:

1. Implement Coast Planning Guidelines regarding cutblock size, distribution and free-growing green-up period.
2. Maintain 5–20% of the watershed in early seral stages (0–15 years).
3. Mature and old-growth forests (>60 years) within the protected forest network and the areas outside the network should together constitute a minimum of 20% of the watershed. Optimally, > 40% of the watershed should consist of mature and old-growth forest.
4. Where necessary, encourage longer green-up periods to promote sufficient habitat diversity.
5. When age class distribution does not provide a variety of seral stages, use stand tending to create the structure of these stages.
6. In areas of extensive second growth, initiate some harvesting prior to culmination age to promote habitat diversity in these uniform landscapes.

3. Broad Planning Considerations For Biodiversity

All planning consideration cannot be addressed at the landscape level. Certain factors will need to be considered at the larger provincial, regional or management unit levels. The following is an interim checklist of broader considerations:

1. Does the watershed contain examples of now scarce but formerly common ecosystems? If so, include them in the forest ecosystem network.
2. Does the watershed contain significant representations of an ecosystem that is generally rare elsewhere? If so, include them in the forest ecosystem network.
3. Does the protected areas network recognize and consider adjacent units (e.g. administrative units, parks, other watersheds)? For example, parks may provide larger contiguous areas of protected blocks or buffers to linkages.
4. Does the watershed include old-growth associated species for which viable populations normally require areas larger than watersheds or are of special provincial interests? If so, attempt to connect forest ecosystem networks in adjacent watersheds and consider provincial objectives for these species.
5. Are the old-growth protected areas selected good representatives of one or more ecosystems? Do better examples exist elsewhere? It may not be helpful to reserve areas simply because of old age; seek the best areas to meet biodiversity objectives.
6. Is there opportunity to trade off small potential old-growth reserves for a larger one elsewhere? If so, consider the biological and economic implications of trade offs.
7. Have the provincial targets been met for protected areas of old growth in each broad ecological unit (e.g. biogeoclimatic subzones)? If not, include them in the forest ecosystem network.
8. Is there opportunity to meet provincial targets for larger, unfragmented blocks of old growth in the watershed? If so, and they have not been met elsewhere, include them in the forest ecosystem network and estimate impacts.

Appendix 3

Submission of the Western Canada Wilderness Committee

The Western Canada Wilderness Committee has played a key role in research projects regarding the Marbled Murrelet, including the discovery of Canada's first confirmed Marbled Murrelet nest in the Walbran Valley on Vancouver Island.

We believe our participation on the Marbled Murrelet Recovery Team has been beneficial, but to our great disappointment a major factor involving the species' viability has not been addressed in the Recovery Plan.

Protection of identified murrelet habitat while research is in progress is essential. Important sub-populations could easily suffer irreversible damage and the population of the species as a whole will continue to decline if important nesting habitat is not protected now.

Unlike most seabirds, the murrelet's nesting habitat is both accessible as well as commercially valuable, thus pressure is very strong to quickly convert this habitat into industrial profits.

The Marbled Murrelet is facing extraordinarily difficult odds given the present logging plans in B.C. As this habitat is rapidly diminishing, it is of paramount importance that protection of identified terrestrial habitat be an integral part of the Recovery Plan.

The Western Canada Wilderness Committee in conjunction with the Pacific Seabird Group (see attachments below) recommends the Carmanah/Walbran forest system on Vancouver Island identified as Marbled Murrelet habitat be deferred from any industrial development while crucial studies are underway and incomplete.

(attachment 1)

Carmanah-Walbran Resolution

A Resolution of the Pacific Seabird Group
Drafted at the Marbled Murrelet Technical Committee Meeting, 25 January 1991

WHEREAS coastal old-growth coniferous forests within 75 km of the ocean are required as nesting habitat for the Marbled Murrelet in British Columbia;

WHEREAS the removal of old-growth forests by logging has probably caused a large decline in Marbled Murrelet populations of British Columbia and now threatens its continued viability in the future;

WHEREAS the first verified Marbled Murrelet nest in Canada has been found in the Walbran Valley, Vancouver Island, and Marbled Murrelet activities indicative of a significant nesting area have been documented in the Carmanah-Walbran Valley system; and

WHEREAS further research is needed to fully determine the geographic extent of nesting, and to estimate the size of the breeding population in the Carmanah-Walbran Valley system and throughout coastal British Columbia;

BE it resolved that the Pacific Seabird Group strongly urges the governments of Canada and British Columbia to support efforts to prevent logging and to permanently set aside the entire Carmanah-Walbran system as a scientific or ecological reserve, and to protect Marbled Murrelet populations for long term research and population monitoring, research which will ultimately provide sound scientific information required for a coastal old-growth management strategy that provides for continued viable populations of Marbled Murrelets throughout British Columbia.

(Attachment 2)

Management of the Marbled Murrelet

A Resolution of the Pacific Seabird Group Drafted at the Marbled Murrelet Technical Committee Meeting, 25 January 1991

WHEREAS the 1982 Pacific Seabird Group resolution on Marbled Murrelets recommended that U.S. and Canadian forest and wildlife management agencies consider Marbled Murrelets in all management plans and other proposed developments that may adversely affect the integrity of old-growth forests, and the Pacific Seabird Group respectfully requested that U.S. and Canadian forest and wildlife management agencies fund studies to investigate the habitat requirements of nesting Marbled Murrelets; and

WHEREAS the 1986 Pacific Seabird Group resolution on Marbled Murrelets recommended that the state, provincial and federal agencies immediately establish an interagency working group to address research and management needs for the Marbled Murrelet, that the Marbled Murrelet be designated as a sensitive species within its North American range, and the U.S. National Forests within 75 km of salt-water include the Marbled Murrelet as a sensitive species in their current National Forest Management Plans; and

WHEREAS there is additional concern because of mortality from entanglement in fishing nets and oil pollution at sea and other factors; and

WHEREAS all of the nests that have been found from southeast Alaska south were located in old-growth trees, thus supporting the old-growth dependency of the species; and

WHEREAS the Marbled Murrelet is a Category II species under the *U.S. Endangered Species Act*, and is a Threatened Species in British Columbia;

THEREFORE Be It Resolved that surveys of Marbled Murrelet be conducted in all old-growth and mature forests prior to any timber harvest or other habitat modification, according to the survey protocol by Paton et al. (1990) (Surveying Marbled Murrelets at Inland Forested Sites: A Guide. United States Department of Agriculture, Forest Service, General Technical Report PSW-120);

AND Be It Further Resolved that when Marbled Murrelet activity is observed indicative of an occupied site that timber harvest or other habitat modification be deferred until such time as it can be shown that the activity will not adversely affect murrelet populations at that location.

Previous Publications

Canadian Whooping Crane Recovery Plan	December 1987
Anatum *Peregrine Falcon Recovery Plan*	October 1988
RENEW Report No. 3 *National Recovery Plan for the Baird's Sparrow*	April 1993
RENEW Report No. 4 *National Recovery Plan for the Roseate Tern*	June 1993
RENEW Report No. 5 *National Recovery Plan for the Greater Prairie-Chicken*	October 1993
RENEW Report No. 6 *National Recovery Plan for the Whooping Crane*	January 1994
RENEW Report No. 7 *National Recovery Plan for the Loggerhead Shrike*	March 1994

Recovery of Nationally Endangered Wildlife

In 1988, the Wildlife Ministers' Council of Canada endorsed a new strategy to rescue wildlife species at risk of extinction and to prevent other species from becoming at risk. Called RENEW (the acronym for Recovery of Nationally Endangered Wildlife), the strategy brings together all agencies, organizations, and interested individuals to work as a team for the recovery of wildlife at risk. RENEW focuses on those species or populations of terrestrial mammals, birds, reptiles, and amphibians that have been designated as extirpated, endangered, or threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The RENEW strategy is implemented by a committee of the same name composed of the directors of provincial, territorial, and federal government wildlife agencies plus the heads of the three major national wildlife organizations (Canadian Nature Federation, Canadian Wildlife Federation, and World Wildlife Fund [Canada]). The RENEW committee establishes a "recovery team" of experts for each species to produce a recovery plan which then becomes the basis for a recovery program carried out by the responsible governments in cooperation with universities, businesses, and private citizens.

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